User's Guide
SLVU819B – February 2013 – Revised August 2014

Evaluation Module for TPS62736 Ultra Low Power Buck Converter

This user's guide describes the TPS62736 evaluation module (EVM). The TPS62736 device is a high-frequency synchronous stepdown dc-dc converter optimized for ultralow-power energy harvesting applications. The converter can provide up to 50 mA of continuous current to a 1.3 V – 5.3 V output from input voltages up to 5.5 V.

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1 Introduction

TPS62736 IC Features

The TPS62736 is a highly integrated ultra low power buck converter solution that is well suited for meeting the special needs of ultra low power applications such as energy harvesting. The TPS62736 provides the system with an externally programmable regulated supply in order to preserve the overall efficiency of the power management stage versus a linear step down converter. Although intended to have input power from an energy storage element such as a Li-Ion battery or super cap, the TPS62736 can accept any input voltage up to 5.5 V, while supplying the rail to low voltage electronics.

The TPS62736 integrates an optimized hysteretic controller for low power applications. The internal circuitry utilizes a time based sampling system in order to reduce the average quiescent current. This allows for the quiescent current consumption to scale with output load levels. The regulated output has been optimized to provide high efficiency across low output currents (< 10 µA) to high currents (50 mA).

To further assist users in the strict management of their energy budgets, the TPS62736 toggles the input good (VIN_OK) flag to signal an attached microprocessor when the voltage on the input supply has dropped below a pre-set critical level. The intent of VIN_OK is to trigger the reduction of load currents to prevent the system from entering an undervoltage condition. Two separate enable signals allow the user to enable/disable the regulated output or place IC into an ultra-low quiescent sleep state. Two separate enable signals allow the enabling or disabling of the regulated output or allow putting the IC into an ultra-low quiescent sleep state.

The output voltage regulation point and input good threshold are set by external resistors. **In order to maximize efficiency at light load, the use of voltage level setting resistors > 1 MΩ is recommended. However, during board assembly or modification, contaminants such as solder flux and even some board cleaning agents can leave residue that may form parasitic resistors across the physical resistors and/or from one end of a resistor to ground, especially in humid, fast airflow environments. This can result in the voltage regulation and threshold levels changing significantly from those expected per the installed resistor values. Therefore, the boards must be carefully cleaned then rinsed with de-ionized water until the ionic contamination of that water. If this is not feasible, then it is recommended that the sum of the voltage setting resistors be reduced.**

TPS62736EVM Features

1. Input voltage range from 2.0 V to 5.5 V
2. Output voltage set to 1.8 V but adjustable from 1.3 V to 5.3 V with external resistors
3. VIN_OK threshold of 2.9 V but adjustable from VOUT to 5.3 V with external resistors
4. Easily accessible headers for IN, IN-SENSE, OUT, OUT-SENSE, GND, VIN_OK
5. Jumpers for EN1 and EN2

1.1 TPS62736EVM Schematic

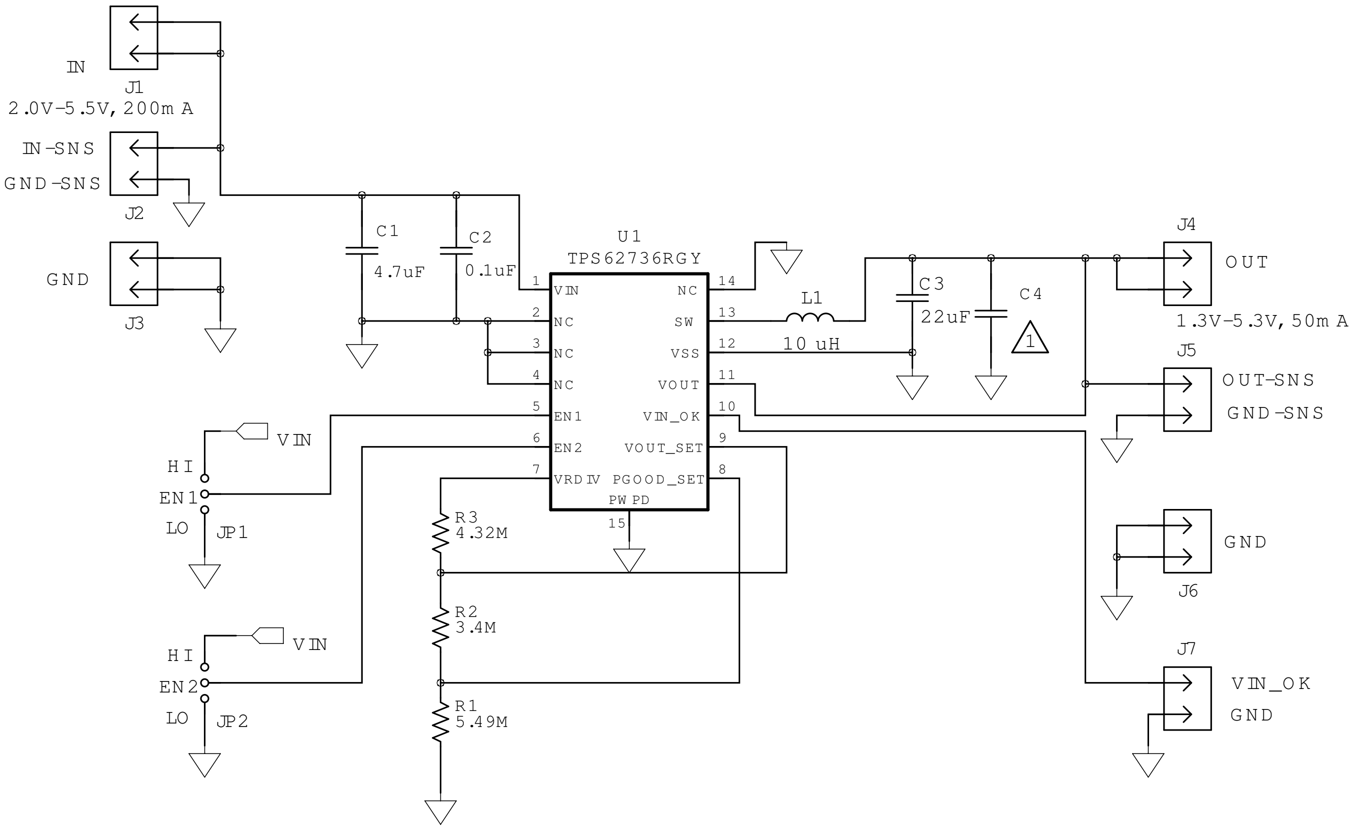

Figure 1. TPS62730 and TPS62733 EVM Board Schematic

2 Performance Specification Summary

Specification	Conditions	MIN	TYP	MAX	UNIT
Input dc voltage, IN		2.0		5.5	V
Output dc voltage, OUT	Adjustable by changing external resistors from 1.3 V to 5.3 V		1.8		V
VBAT_OK threshold	Adjustable by changing external resistors from OUT to 5.3 V		2.9		V
Output current		0		50	mA

3 Test Summary

3.1 Recommended Equipment

- Adjustable dc power supply between 2.0 V and 5.5 V with the adjustable current limit set to approximately 100 mA
- Load: system load or resistive load ≥ 300 Ω
- Two digital multimeters configured to measure voltage (equivalent or better)
- Two digital multimeters configured to measure current (equivalent or better). **NOTE:** Due to the input current pulses inherent to a hysteretically-controlled converter, the input current meter must be capable of filtering and/or averaging in order to measure the correct value. Adding a large (> 100 µF) capacitor between IN and GND may be necessary to assist with filtering. Use of a sourcemeter, configured to regulate voltage and measure current, or power, or both current and power is also recommended.
- Oscilloscope with up to four voltage probes

3.2 Equipment and EVM Setup

Table 1. Setup I/O Connections and Configuration for Measuring Efficiency of TPS62736 EVM

Jack and Component (Silk Screen)	Description	Connect or Adjustment To:
J1 (IN)		Negative lead of current meter (CM#1)
J2-1 (+ IN SNS)	Kelvin connection to capacitance	Positive lead of voltmeter (VM#1)
J2-2 (- GND SNS)	Kelvin connection to capacitance	Negative lead of voltmeter (VM#1)
J3 (GND)		Power supply negative lead
J4 (OUT)		Positive lead of current meter (CM#2)
J5-1 (+ OUT SNS)	Kelvin connection to capacitance	Positive lead of voltmeter (VM#2)
J5-2 (- GND SNS)	Kelvin connection to capacitance	Negative lead of voltmeter (VM#2)
J6 (GND)		Negative lead to load resistance
J7-1 (VIN_OK)	Push-pull output of comparator that indicates the status of the input voltage	n/a
J7-2 (GND)		n/a
JP1 (EN1)	EN1 = HI and EN2 = x implements full standby mode. Switching converter and VIN_OK indication is off (ship mode).	EN1 = LO
JP2 (EN2)	EN1 = LO and EN2 = HI implements full buck converter mode. EN1 = LO and EN2 = LO implements partial standby mode. Switching converter is off, but VIN_OK indication is on.	EN2 = HI

Table 1 and Figure 2 show the test setup for measuring efficiency.

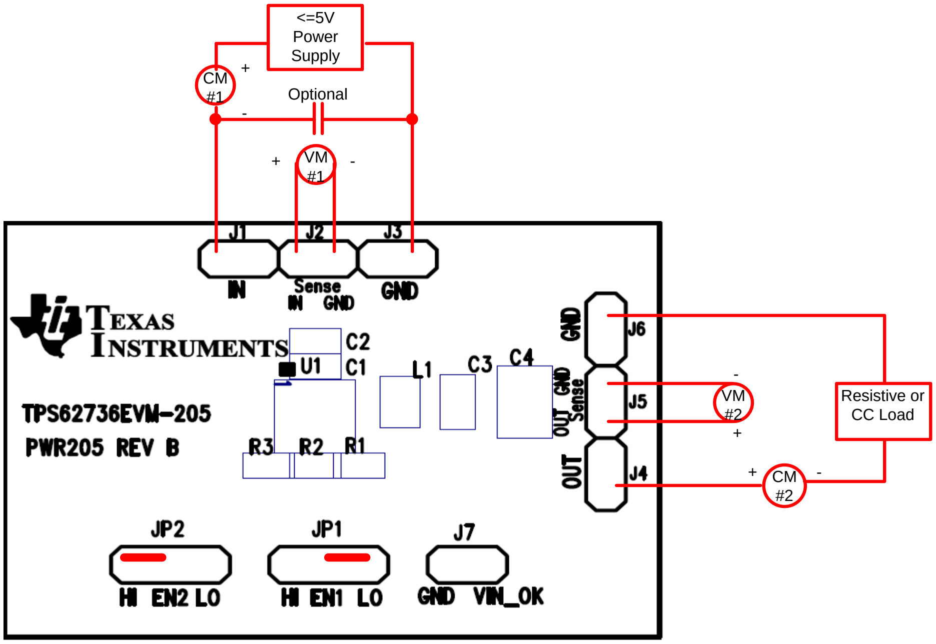

Figure 2. EVM Test Setup for Measuring Efficiency

3.3 Tips when Measuring Efficiency

1. Ensure that the EVM setup is according to Table 1 and Figure 2, and preset the power supply to a voltage less than 5.5 V at a current limit of approximately 100 mA.
2. Slowly increase the system load current until 50 mA is reached.

3.4 Tips for Taking Scope Plots

1. If measuring DC waveforms similar to those shown in Figure 3 – Figure 7, set the timebase as shown in the plot and connect the probes to the applicable headers (IN, OUT, VBAT_OK) or SW pin and the closest GND header.
2. If measuring AC waveforms such as output voltage ripple, set the timebase as shown in the plot, remove the voltage probe hat, connect the probe tip to the top of capacitor C3 and a short ground lead to capacitor C3's ground.
3. Please note that when measuring switching waveforms, the timebase may need to be adjusted as the output load current adjusts due to the hysteretic control methodology.

Test Results (Taken on the TPS62730EVM-205)

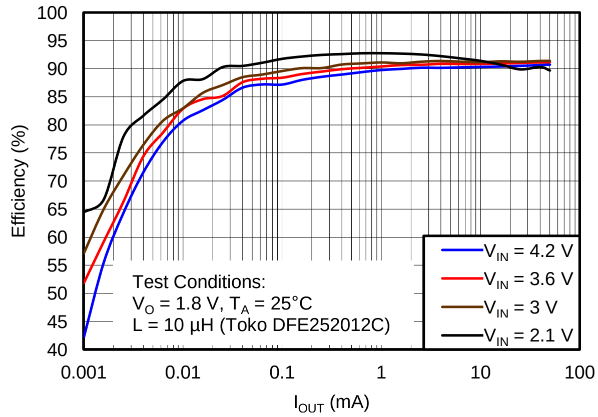

Figure 3. Efficiency Versus Load Current, V_{OUT} = 1.8 V

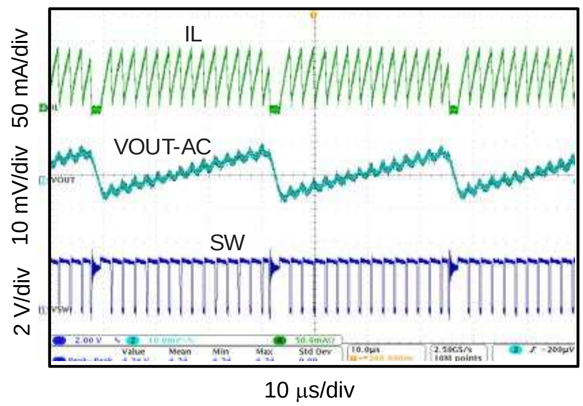

Figure 4. Steady State Operation with RO = 50 Ω

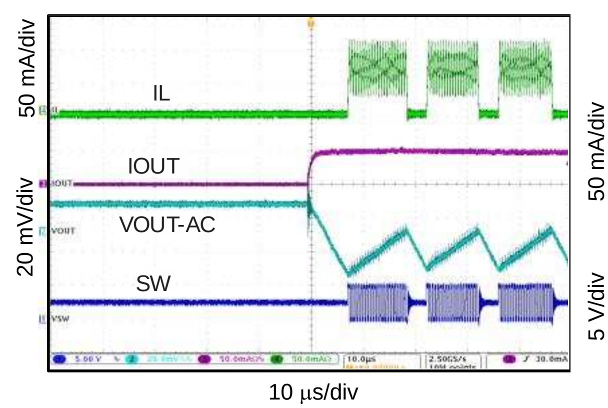

Figure 5. Load Transient Response

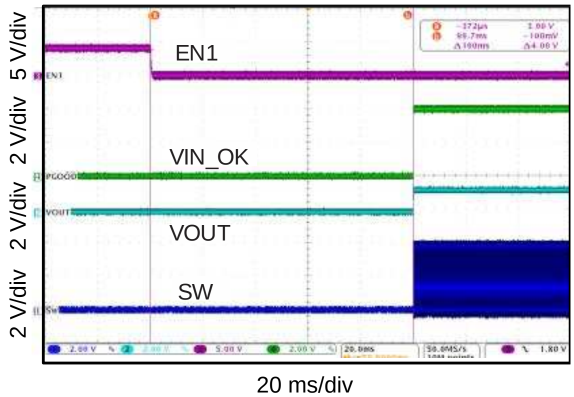

Figure 6. Ship-Mode Startup Behavior

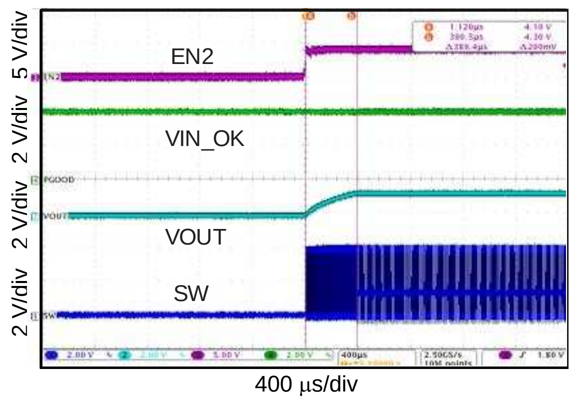

Figure 7. Standby-Mode Startup Behavior

4 PWR205 PCB Layout and Bill of Materials

4.1 REV A PCB Layout (FUNCTIONAL)

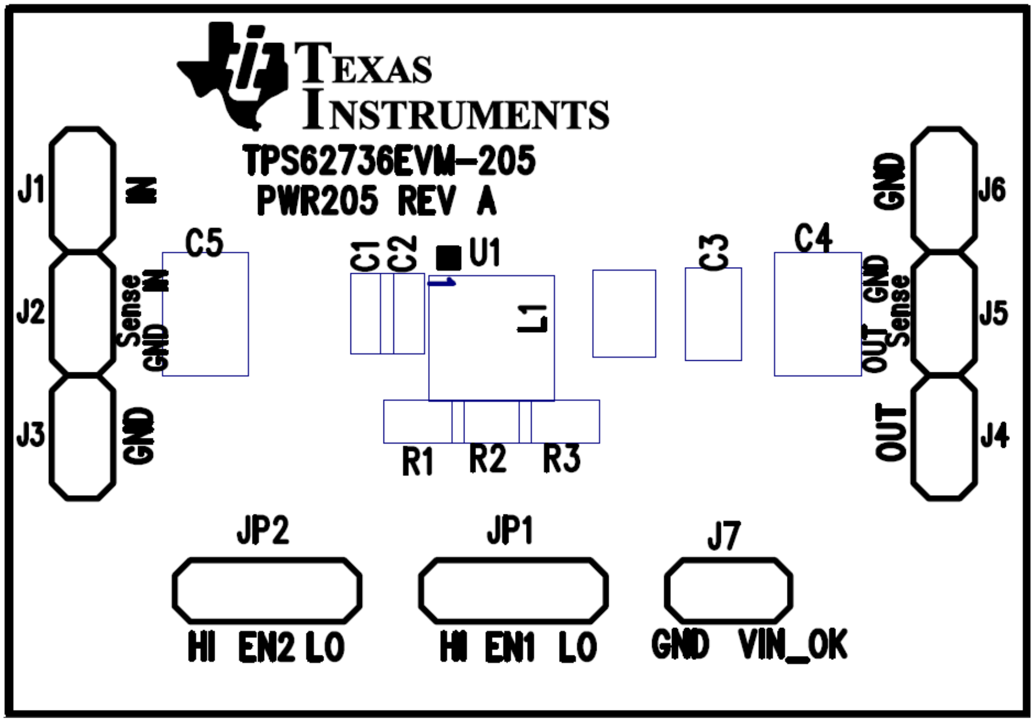

Figure 8. Assembly Layer

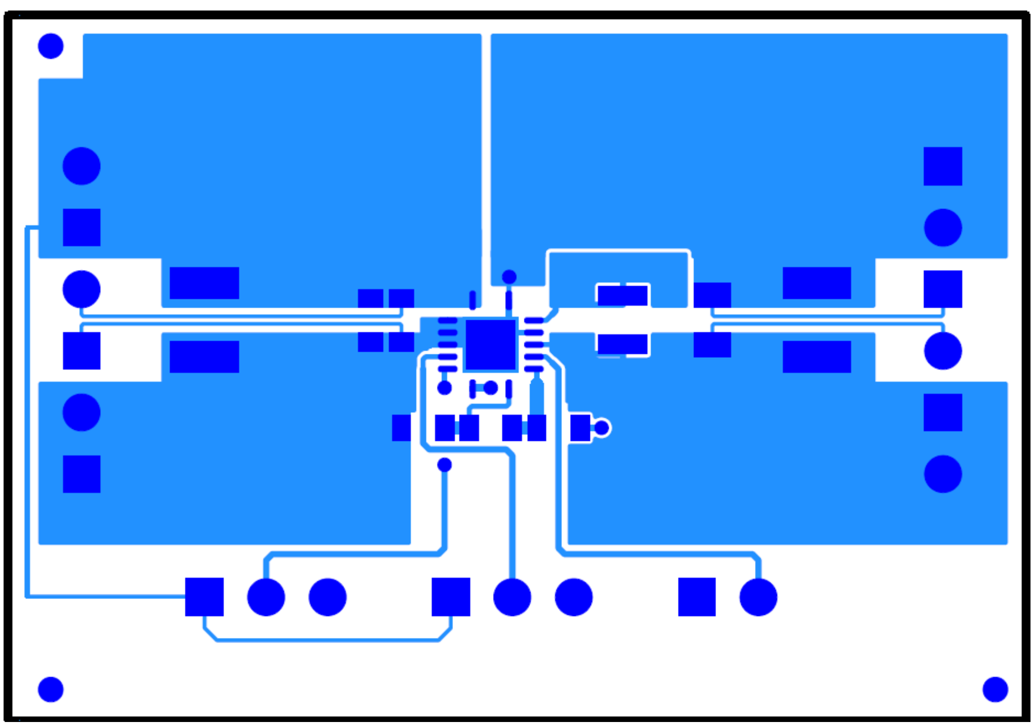

Figure 9. Top Layer

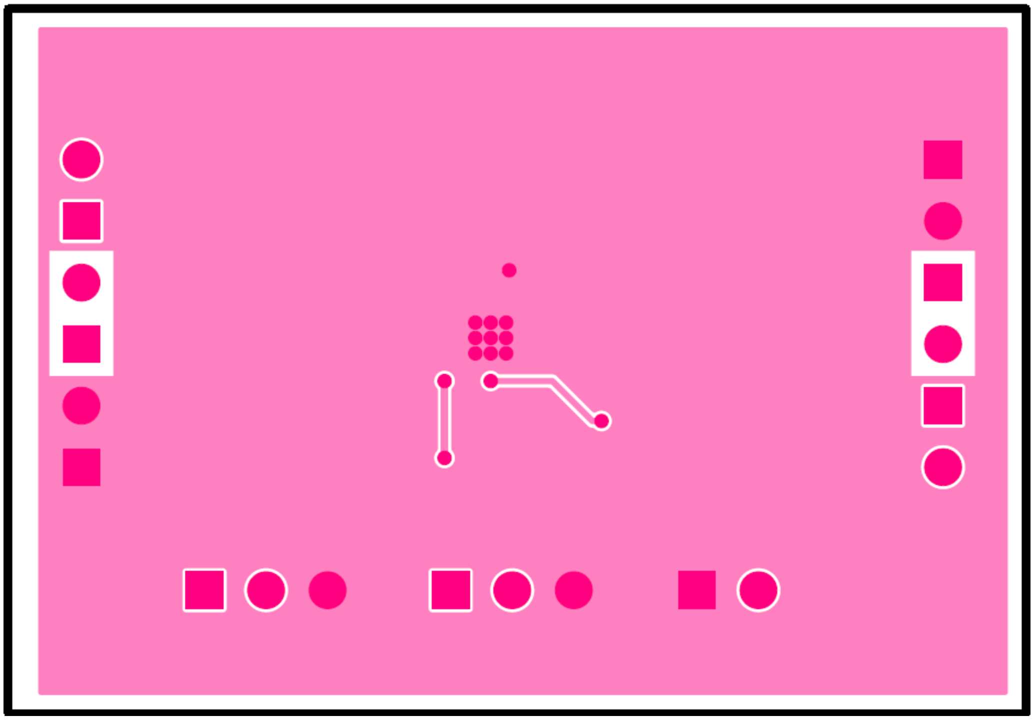

Figure 10. Bottom Layer

4.2 REV B PCB Layout (BEST)

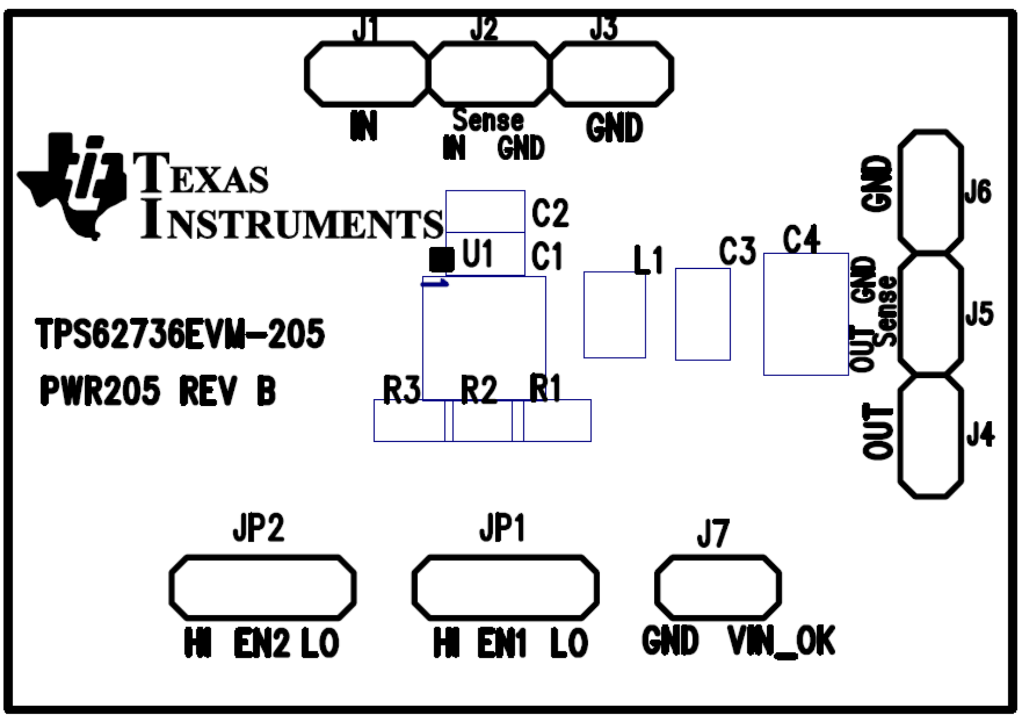

Figure 11. Assembly Layer

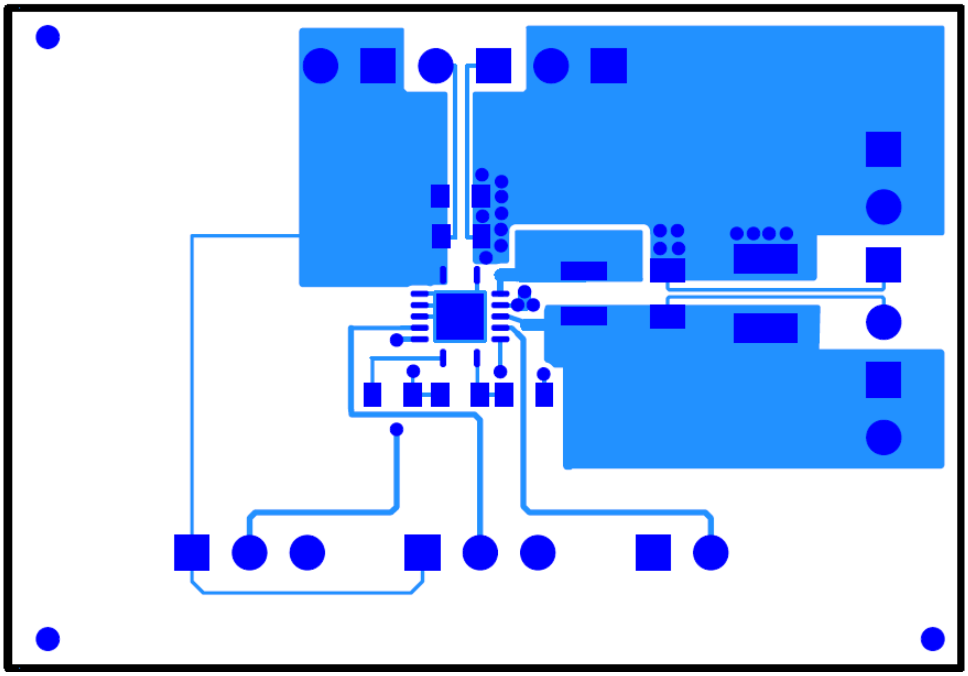

Figure 12. Top Layer

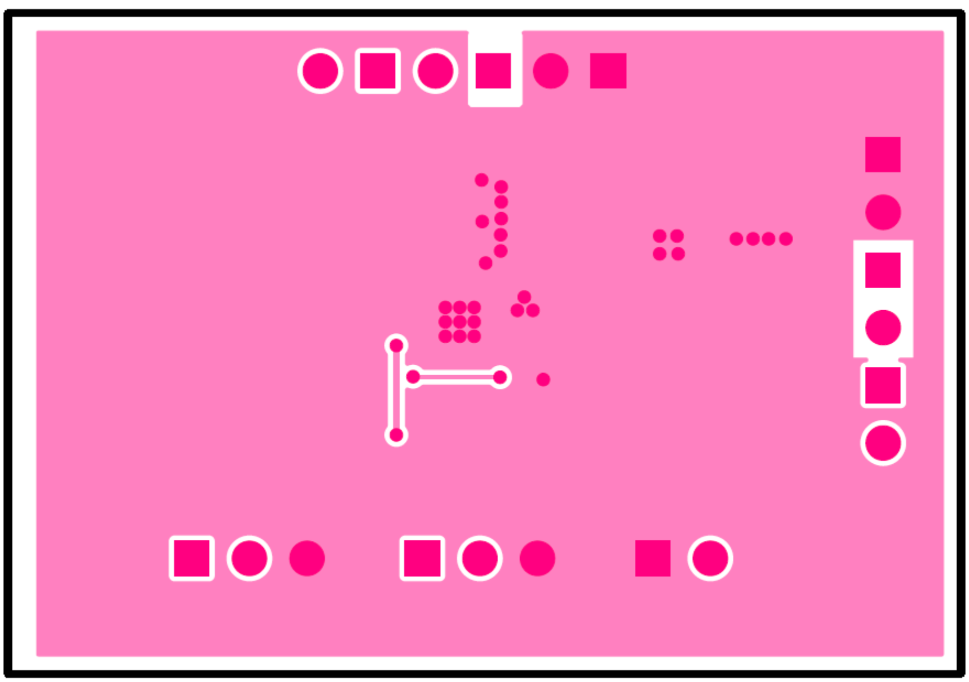

Figure 13. Bottom Layer

4.3 Bill of Materials

Table 2 lists the TPS62736EVM BOM.

Table 2. PWR205 Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C2	0.1uF	Capacitor, Ceramic Chip, 10V, X5R, +10%	603	STD	STD
1	C1	4.7uF	Capacitor, Ceramic Chip, 10V, X5R, ±10%	603	STD	STD
1	C3	22uF	Capacitor, Ceramic Chip, 6.3V, X5R, +20%	805	STD	STD
0	C4	DNP	Capacitor, Ceramic Chip, xxV, ±10%	1210	Std	STD
7	J1-7	PEC02SAAN	Header, Male 2-pin, 100mil spacing,	0.100 inch x 2	PEC02SAAN	Sullins
1	L1	10uH	Inductor, SMT, 1.4A, 216mΩ Inductor SMT, 500mA, 500mΩ Inductor SMT, 250mA, 500mΩ Inductor SMT, 500mA, 390mΩ	2.5mm x 2.0mm x 1.20mm 2.5mm x 2.0mm x 1.20mm 2.5mm x 2.0mm x 1.00mm 2.8mm x 2.8mm x 1.35mm	DFE252012C-1239AS-H-100N 74479889310 74479888310 744029100	TOKO Wurth Elektronik Wurth Elektronik Wurth Elektronik
2	JP1-2	PEC03SAAN	Header, Male 3-pin, 100mil spacing,	0.100 inch x 3	PEC03SAAN	Sullins
1	R3	4.32M	Resistor, Chip, 1/16W, 1%	603	STD	STD
1	R2	3.4M	Resistor, Chip, 1/16W, 1%	603	STD	STD
1	R1	5.49M	Resistor, Chip, 1/16W, 1%	603	STD	STD
1	U1	TPS62736RGY	IC, Ultra Low Power Harvester Power Management Core	VQFN	TPS62736RGY	TI
2	--		Shunt, 100-mil, Black	0.100	929950-00	3M

Revision History

Changes from A Revision (May 2013) to B Revision	Page
• Changed content in the bill of materials	11

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications could void the user's authority to operate the equipment.

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- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Industry Canada Compliance (English)

For EVMs Annotated as IC – INDUSTRY CANADA Compliant:

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Concerning EVMs Including Radio Transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concerning EVMs Including Detachable Antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Canada Industry Canada Compliance (French)

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Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

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1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry’s Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after user obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after user obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless user gives the same notice above to the transferee. Please note that if user does not follow the instructions above, user will be subject to penalties of Radio Law of Japan.

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